1900MNRAS..61...70C

On Observations of Capella as a Double Star made at the Royal Observatory, Greenwich. By W. H. M. Christie, M.A., F.R.S., Astronomer Royal.

The observations of *Capella* as a double star, initiated by Mr. Dyson and Mr. Lewis, have been continued at every favourable opportunity, and this rapid binary has now been followed through two and a half revolutions. The following observations have been made in continuation of those published in the *Monthly Notices* for June, vol. lx. p. 595.

Date (Astronomical) 1900.			Date from Jan. 1, 1900.	Observer.	Position-Angle.	Mean.	Hour-Angle.
	d	h	d		°	°	h
July	10	3½	190·1	Mr. Bryant	293·9	294·2	6¾ W.
		3½		Mr. Bowyer	294·6		6¾ W.
	11	0½	191·1	Mr. Bryant	289·6	300·5	4¼ W.
		2		Mr. Lewis	311·5		2½ W.
	12	0½	192·0	Mr. Lewis	288·2	286·6	2¾ W.
		0½		Mr. Bowyer	280·0		2¾ W.
		1¼		Mr. Bryant	291·5		3½ W.
	13	1	193·1	Mr. Bryant	288·4	288·8	3 W.
		3¾		Mr. Bowyer	289·9		5¾ W.
		4		Mr. Christie	288·1		6 W.
	14	3	194·1	Mr. Bryant	284·1	284·1	5½ W.
	15	16	195·7	Mr. Bowyer	272·7	272·7	5¼ E.
	16	3½	196·1	Mr. Bowyer	272·5	276·6	6 W.
		3½		Mr. Witchell	280·7		6 W.
	18	0½	198·0	Mr. Bowyer	265·8	266·9	3 W.
		0½		Mr. Furner	261·9		3 W.
		2		Mr. Witchell	273·0		4½ W.
Aug.	13	23¼	225·0	Mr. Furner	190·0	190·8	3½ W.
		23¼		Mr. Bowyer	185·7		3½ W.
		23½		Mr. Bryant	196·6		3¾ W.
	15	22½	226·9	Mr. Bryant	189·2	189·2	3 W.
	28	22	239·9	Mr. Bryant	142·0	142·0	3½ W.
Sept.	3	22¾	246·0	Mr. Bryant	111·2	111·2	4½ W.
	5	22	247·9	Mr. Bryant	102·4	106·4	3¾ W.
		22¼		Mr. Dyson	105·7		4 W.
		22¾		Mr. Lewis	111·2		4½ W.
	7	21¾	249·9	Mr. Bryant	95·8	95·8	3¾ W.
	9	23½	252·0	Mr. Bryant	88·8	88·8	5¾ W

1900MNRAS..61...70C

Date (Astronomical) 1900.			Date from Jan. 1, 1900.	Observer.	Position-Angle.	Mean.	Hour-Angle.
	d	h	d		°	°	h
Sept.	10	21½	252·9	Mr. Bryant	84·9	89·8	3¾ W.
		21¾		Mr. Lewis	94·7		4 W.
	11	23	254·0	Mr. Bryant	82·5	82·5	5¼ W.
	12	21½	254·9	Mr. Bryant	78·4	81·7	3¾ W.
		22½		Mr. Lewis	84·9		4¾ W.
	14	23¾	257·0	Mr. Bryant	73·2	73·2	6¼ W.
	16	22	258·9	Mr. Bryant	67·2	67·2	5 W.
	18	21½	260·9	Mr. Bryant	56·6	56·6	4½ W.
	19	21¼	261·9	Mr. Bryant	55·1	58·7	4¼ W.
		22		Mr. Christie	62·4		5¼ W.
	21	23¾	264·0	Mr. Lewis	58·0	58·0	6¼ W.
	30	20¼	272·8	Mr. Bryant	17·4	17·4	4 W.
Oct.	7	20	279·8	Mr. Bryant	349·6	349·6	6 W.
	21	21	293·9	Mr. Bryant	290·2	290·2	6 W.
Nov.	7	20½	310·8	Mr. Bryant	239·5	239·5	6½ W.
	9	22	312·9	Mr. Bryant	232·0	232·0	5¾ W.
	23	8	326·3	Mr. Lewis	193·5	193·5	4½ E.
	27	9½	330·4	Mr. Bowyer	186·7	186·7	3¼ E.
Dec.	7	8	340·3	Mr. Bryant	144·4	144·4	4¼ E.
	10	8	343·3	Mr. Lewis	(120 ±)		4 E.

It is to be noted that *Capella* cannot be observed within about 2½ hours of the meridian (except by means of a diagonal reflector), the eye end of the telescope being too near the floor when the telescope is pointed to the neighbourhood of the zenith.

The observations have been grouped to obtain normal places, the observations in the second and third revolutions being made comparable with those in the first by subtracting 104 days and 208 days respectively from the dates of observation (expressed in days from the beginning of the year). The period has thus been provisionally assumed to be 104 days, as deduced by Mr. Newall from spectroscopic observations, though the observations hitherto published seem hardly sufficient to fix the period within a day. The visual observations so far obtained would be somewhat better satisfied with a period of about 103 days, but the data are necessarily uncertain, and further observations are required to determine whether the assumed period of 104 days may require to be slightly diminished. The observations from April 23 to May 11 have not been included in the groups, as the observers seem to have been to some extent influenced by colour effects which affected the measures, *Capella* having been observed at a large hour-angle in the evening sky. The mean position-angles for the groups and the mean daily motion for the intervals between

1900MNRAS..61...70C

the groups are given in the following table, together with the corresponding quantities calculated for a provisional orbit, found by trial to approximately satisfy the observations so far obtained :—

Day from beginning of Year.	Observed Angle.	Computed Angle.	C−O.	Observed Mean Daily Motion.	Computed Mean Daily Motion.	Computed Radius Vector.
d	°	°	°	°	°	
87·7	290·7	292·7	+2·0	2·45	3·08	0·97
92·8	278·2	277·0	−1·2	2·41	2·82	1·01
105·9	246·6	240·0	−6·6	3·69	3·16	1·03
121·2	190·1	191·7	+1·6	3·55	3·71	0·91
134·8	141·8	141·3	−0·5	3·89	3·47	0·90
147·2	93·6	98·3	+4·7	3·32	3·25	0·95
156·5	62·7	68·1	+5·4	3·47	3·71	0·94
169·6	17·3	19·6	+2·3	4·47	4·18	0·85
175·8	349·6	353·7	+4·1	3·70	3·84	0·84

The values of the mean daily motion show that the apparent path is not far from circular, and a closer examination indicates that the plane of the orbit is inclined about 30° to 35°, the line of nodes being at about 80°, and that there is a very small eccentricity in the true orbit. This accords satisfactorily with Mr. Newall's spectroscopic observations, which, with a period of 104 days, give 1900 June 4, represented by 154^{d} in the table, as the epoch of maximum relative velocity, corresponding to position-angle 76° in the apparent orbit, which is quite close to the line of nodes at about 80° as indicated by the visual observations. For the provisional orbit used for the calculated position-angles and mean daily motions the following elements have been taken :—

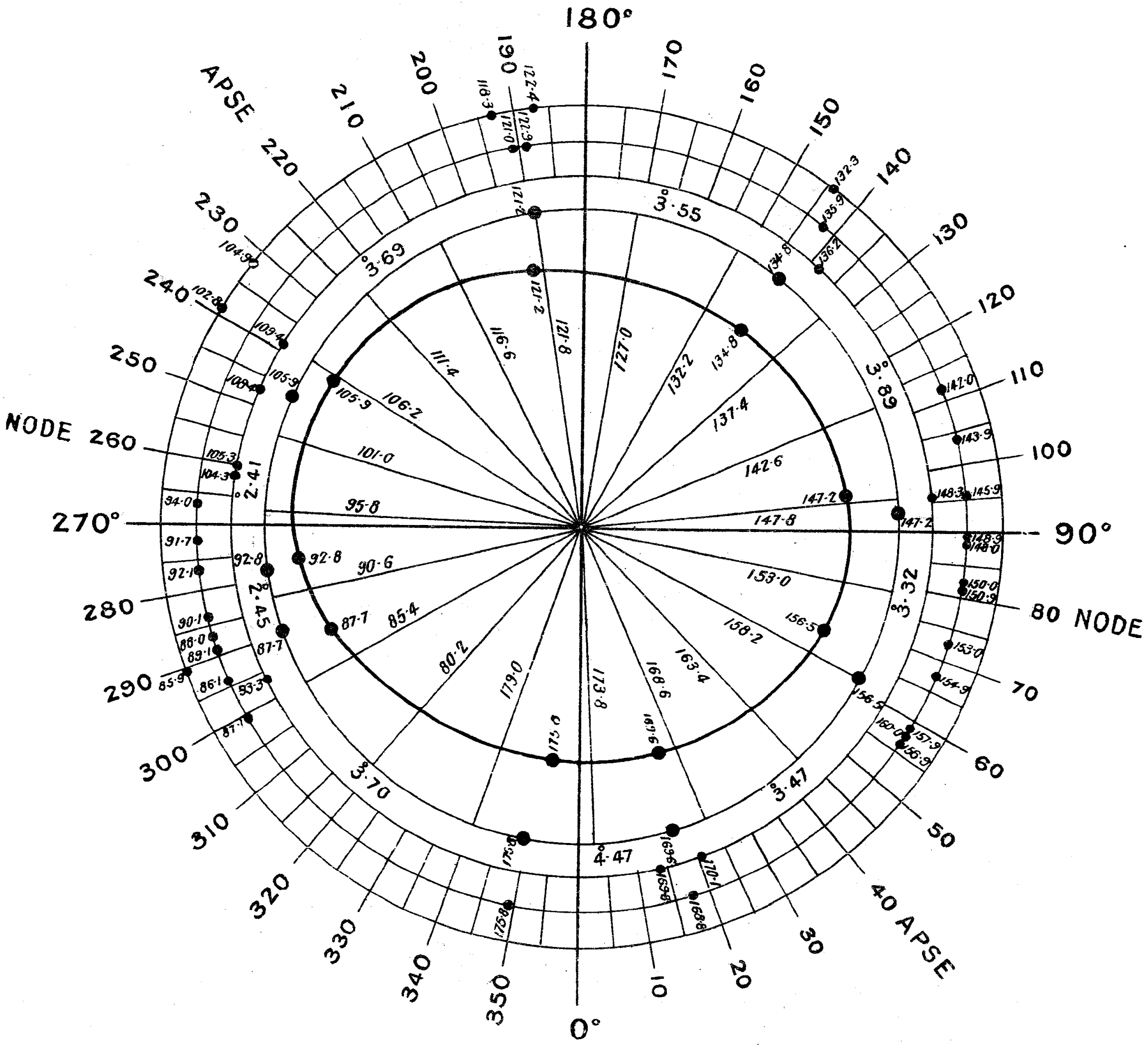
Inclination, 30°. Position-angle of node, 80°.
Eccentricity, 0·05. Position-angle of periastron, 40°.

The values of C−O indicate that this orbit represents the observations so far available within the limits of error for such a difficult double star, but further observations and an alteration in the assumed period of revolution would doubtless materially modify these elements, especially the eccentricity and periastron. The comparison with this provisional orbit, however, suffices to indicate that the visual observations accord satisfactorily with the spectroscopic observations as regards the period of revolution, the date of passing through the node (corresponding approximately to date of maximum velocity of the solar component) and small eccentricity.

The diagram exhibits the results of the two tables graphically, the position-angles observed during the three revolutions being indicated on the three circles with the corresponding dates,

1900MNRAS..61...70C

Position Angles of Capella observed as a Double Star at the Royal Observatory, Greenwich, 1900, *with the deduced Apparent Ellipse.*



The observations of position angle are indicated on three circles by the day of the year, 104 days and 208 days respectively being subtracted in the second and third revolutions to make them comparable with the first. The means of groups are indicated on the innermost circle, and the corresponding computed positions on the apparent ellipse.

1900MNRAS..61...70C

expressed in days reckoned from 1900 January $1^{\mathrm{h}}\cdot0$ G.M.T. (astronomical), 104 days being subtracted for the second revolution, and 208 days for the third. On the innermost circle the mean observed position-angles for groups are indicated with the dates, and within this the apparent ellipse (provisional) with the position-angles corresponding to the mean dates of groups. The position-angles for every 18° of mean anomaly (representing 5·2 days) are also shown for convenience. The observed mean daily motion for the intervals between groups is also shown round the innermost circle.

As regards the distance of the components, three actual measures have been made, besides estimates by different observers, which on the whole accord fairly with the measures, due allowance being made for the variation in distance at different parts of the apparent orbit. The following are the measures of distance made, together with the radii computed for the apparent orbit in terms of the mean distance :—

1900	d	″		
Sept. 6	248	0·09	0·94*a*	6 measures by Mr. Bryant, micrometer read by Mr. Lewis.
20	158	0·06	0·93*a*	2 measures by Mr. Bryant.
22	160	0·06	0·92*a*	Measures by Mr. Lewis, in terms of the breadth of the spider lines.*

From these measures it would result that $a = 0''\cdot08$, and therefore that the maximum distance of the components would be $0''\cdot083$, at about 100^{d}, and the minimum $0''\cdot066$, at about 170^{d}. This value for *a* accords as closely as can be expected with Mr. Newall's data from spectroscopic observations in combination with Dr. Elkin's value of the parallax, viz., $0''\cdot08$. In fact, with an inclination of 30°, $a = \frac{52}{93} \times \frac{1}{\sin 30^\circ} \times 0''\cdot08 = 0''\cdot09$.

It is of interest in this connection to note that *κ Pegasi* has been observed at Greenwich (by Mr. Lewis and also by Mr. Dyson in 1896 and 1897), when the distance of the components (as inferred from the angular velocities) was only $0''\cdot05$ or $0''\cdot06$, and that observations of 42 *Comæ* (Σ 1728) were obtained (also by Mr. Dyson and Mr. Lewis) just before and just after nearest approach or occultation, when the distance was in each case between $0''\cdot05$ and $0''\cdot04$, the distances being fixed with great accuracy from the circumstances of the orbit. It may be noted also that *κ Pegasi* (which is now again becoming a difficult object) was observed on the last four nights on which *Capella* was observed, viz. November

---

* There are two spider lines in the filar micrometer, and Mr. Lewis found that the thinner line, $0''\cdot08$ in breadth, covered the star disk completely in all positions except that corresponding to the direction of elongation 60°, while the thicker wire, $0''\cdot14$ in breadth covered it in that position. It results that the apparent star disk under the conditions of observation was less than $0''\cdot08$ in diameter for each component, and that the distance of the components was about $0''\cdot06$.

1900MNRAS..61...70C

23, 27, December 7 and 10, and that the elongation in the case of *Capella* was noted as being quite as distinct as in the case of *κ Pegasi*, for which Mr. Lewis estimated the distance as under 0″·1. On December 10 Mr. Lewis (though unable to get a satisfactory measure of position-angle owing to unsteadiness of the image shortly before the sky clouded over) satisfied himself of a distinct elongation in *Capella*, the definition being very fine momentarily, so that he was able to *count* eight rings round the star, using a magnifying power of 1120, there being at least ten or more complete rings visible.

The two components of *Capella* do not differ much in brightness, but there is a consensus of opinion amongst the observers that the position-angles as given indicate the direction of the fainter star. Mr. Bryant in particular has noted his impression as to this on several occasions, and I can confirm this on July 13, when the star appeared distinctly egg-shaped, with the smaller end in the position-angle given. On September 19 I had the impression that the fainter star was in the first quadrant, not the third, but the elongation was then smaller, and I do not feel so much confidence as to which end of the elongated image was the smaller.

In making the observations, neutral-tinted or deep-blue shades were used to reduce the brightness of the star. Many of the observations were made in the daytime, when the brightness was naturally much reduced.

Royal Observatory, Greenwich:
1900 *December* 14.

ζ Herculis. By T. Lewis.

R.A.	$16^h\ 37^m\ 31^s$	1900.	Mag. A. 3·0	Yellow.
N.P.D.	58° 13′ 1″		Mag. B. 6·5	Bluish Green.

Sir William Herschel found this star to be double on 1782 July 18, and on July 21 he measured the position-angle as 69°·3. In 1795 he noted that it was in the n.f. quadrant, and remarked that the distance was smaller than in 1782. In 1802 and 1803 he failed to separate the pair, but measured the angle on three occasions:—

1802·74	219°·2
1802·81	5°·7
1803·29	116°·8

Thus, while it was evident that the pair formed a binary system of short period, these observations left the matter in a very unsatisfactory state, which did not improve by the failure of Sir J.